REMARKS

I. Amendment to Drawings, Specification and Claims

The Figures 1b, 2b, 3b, 4b and 5b have been amended to correct recently found minor inconsistencies between the figures and the specification. Likewise, the specification has been amended to be in conformity with the Figures and the Examples described in the specification. Submitted herewith is a Request for Drawing corrections, along with Replacement Sheets for the Figures 1b, 2b, 3b, 4b and 5b. No new matter is being added, and the Examiner is respectfully requested to allow such amendments.

Claims 1, 11-12, 14 and 75-90 are currently pending. Independent Claims 1 and 77 have been amended to more clearly define the structure of the invention. Claims 1, 12, 14, and 75-78 have been amended to address the informalities noted by the Examiner. Claims 79-89 have been added to define alternative embodiments of the invention.

II. Response to the Rejection of Claims 1, 11, 12, 14 and 75-78 under 35 U.S.C. 112, 2nd Paragraph

Claim 1 has been amended at line 12 to provide sufficient antecedent basis for the first and second p-type sub-window layers, as noted by the Examiner. Claim 1 now recites that the at least one doped window layer has at least two p-type sub-window layers, where one is a first p-type sub-window layer and the other is a second p-type sub-window layer. For this reason, Claims 11, 12, 14, 75, and 76 have likewise been corrected.

Claim 76 has been amended to identify the proper p-type sub-layer windows.

Claim 77 has been amended to recite the necessary antecedent basis noted by the Examiner. Likewise, Claim 78 depends from amended Claim 77 and thus also has sufficient antecedent basis.

Accordingly, Applicants request withdrawal of the objections and the rejections of the claims under 35 U.S.C. §112, 2nd paragraph.

III. Response to the Rejection under 35 U.S.C. §102(b) of Claims 1, 11, 12, 75, and 76 as being anticipated by the Ma et al. (1994) reference.

The independent Claims 1 and 77 recite a photovoltaic cell having at least one absorber layer and at least one doped window layer. The doped window layer has at least two p-type sub-window layers, a first p-type sub-window layer and a second p-type sub-window layer. The independent claims 1 and 77 have been amended to recite that the first

and second p-type sub-window layers have the same chemical composition - nanocrystalline silicon.

The first p-type sub-window layer is adjacent the absorber layer (i-layer) and forms a desirable electrical junction therewith. The second p-type sub-window layer is adjacent the first p-type sub-window layer and has high optical transmission. The second p-type sub-window layer has a transparency and a thickness that are greater than the first p-type sub-window layer.

In contrast, the Ma et al. reference does not teach or suggest having first and second p-type sub-window layers formed from nanocrystalline silicon. Further, the Ma et al. reference does not teach or suggest a second p-type layer having a transparency and a thickness that are both greater than the transparency and the thickness of the first p-type layer.

The Ma et al. reference discloses a photovoltaic cell having a thin microcrystalline silicon carbide layer (μc-SiC) deposited between a transparent conductive oxide layer and a heterojunction of amorphous silicon carbide and amorphous silicon (a-SiC/a-Si). As noted by the Examiner, the high optical transmission characteristic of the layers disclosed in the Ma et al. reference rely on layers that are on the order of a few nanometers thick.

However, there is no teaching or suggestion in the Ma et al. reference that a doped window layer may be formed having first and second p-type sub-window layers formed from nanocrystalline silicon. Instead, the Ma et al. reference discloses p-type layers formed from amorphous silicon carbide (a-SiC) and microcrystalline silicon carbide (μc-SiC). The Ma et al. reference teaches that alloying the amorphous silicon with carbide provides improved photovoltaic properties. (See Ma et al., pg. 418, Col. 2, Lines 1-10). In contrast, as now claimed in the present invention, the first and second p-type sub-window layers are comprised of a nanocrystalline silicon, and are *not* an amorphous silicon alloyed with carbide. As such, the nanocrystalline silicon p-type sub-window layers of the present invention are structurally distinguishable from the p-type layers of the Ma et al. reference.

Additionally, in the present invention, the second p-type sub-window layer (which is between the first p-type sub-window layer and transparent conductive oxide layer) has both improved transparency *and* greater thickness than the first p-type sub-window layer. The Ma et al. reference teaches away from the present invention by requiring the exact opposite of the present invention. That is, the Ma et al. reference shows that the efficiency of a photovoltaic

cell decreases as the thickness of the μc-SiC layer approaches the thickness of the TCO/p a-SiC layer of 7.5 nm. (See Ma et al., pg. 419, Col. 2, first full paragraph, line 1-3 and Fig. 8).

It is to be understood that, while the Ma et al. reference provides an investigation of layer thicknesses from 1nm-15nm, the Ma et al. reference points our that the structure of an adequate photovoltaic cell provides a second p-layer (adjacent to the TCO layer) that is from "as thin as 2 nm" to an "optimal thickness of 5 nm." (See Ma et al., pg. 417, Col. 1, 3rd Par., Lines 5-8; and pg. 420, Col. 2, Lines 2-7). Clearly, the Ma et al. reference's second p-layer is thinner than the Ma et al. reference's first p-layer and, therefore, fails to anticipate the relative thicknesses as now recited in the amended claims herein.

Thus, at least the independent Claims 1 and 77 are patentable over the Ma et al. reference. For at least this reason, the dependent Claims 11, 12, 75 and 76 are likewise patentable. Applicants respectfully request withdrawal of the rejections based on the Ma et al. reference.

IV. Response to the Rejection under 35 U.S.C. §102(b) of Claims 1-12, 14-16, 70, and 72-74, as being anticipated by the Kishimoto et al. (US 6,242,686) reference.

As stated above, the independent Claims 1 and 77 recite a photovoltaic cell having at least one absorber layer and at least one doped window layer. The doped window layer has at least two p-type sub-window layers formed from nanocrystalline silicon. A first p-type sub-window layer is adjacent the absorber layer and forms a desirable electrical junction therewith. A second p-type sub-window layer is adjacent the first p-type sub-window layer and has high optical transmission.

The Kishimoto et al. reference does not teach or suggest a second p-type layer having a transparency and a thickness that are both greater than the transparency and the thickness of the first p-type sub-window layer.

The Kishimoto et al. reference teaches away from the photovoltaic cell as now claimed. Rather, the Kishimoto et al. reference discloses disposing a first p-layer (7) adjacent to a TCO layer and adjacent to a second p-layer (8). The first p-layer of Kishimoto (which is located in a similar location relative to the stack arrangement of the photovoltaic cell as the "second p-type sub-window layer" as described in the present invention) is disclosed a having a thickness of 5 nanometers or less. (See Kishimoto et al., Col. 5, Lines 6-12). The second p-layer of Kishimoto (which corresponds to the "first p-

type sub-window layer" of the present invention) is taught to be greater in thickness than the first p-layers. (See Kishimoto et al., Embodiment 1, Col. 8, Lines19-25; Embodiment 2, Col. 9, Lines 10-17; and Figs. 2 and 6). Additionally, the second p-type layer of Kishimoto is not positively doped, but rather is actually first formed as an "i-layer" into which the dopant of the first layer diffuses.

Additionally, the Kishimoto et al. reference does not teach or suggest the use of silicon having a nanocrystalline microstructure in the first and second p-layers.

Thus, at least the independent Claims 1 and 77 are distinguished from and patentable over the Kishimoto et al. reference. For at least this reason, the dependent Claims 11, 12, 14, and 75 are likewise patentable. Independent Claim 77 and dependent Claim 78 include the same limitation of a silicon p-type layer having a nanocrystalline microstructure and are likewise patentable over the Kishimoto et al. reference. Applicants respectfully request withdrawal of the rejections based on the Kishimoto et al. reference.

V. Response to the Rejection under 35 U.S.C. §103 of Claim 14 as being obvious over the Ma et al. reference and in view of the Sano et al. reference.

Claim 14 depends from Claim 1 and includes all of the limitations recited therein and stated previously. Claim 14 further recites that a buffer semi-conductor layer is positioned between the absorber-layer and the first p-type sub-window layer.

The Examiner correctly observes that the Ma et al. reference lacks teaching to dispose a buffer layer between the absorber layer and the first sub-window layer. As previously stated, the Ma et al. reference further lacks first and second p-type sub-window layers formed from nanocrystalline silicon.

The Sano et al. reference adds nothing to overcome the deficiencies of the Ma et al. reference. Like the Ma et al. reference, the Sano et al. reference lacks teaching the use of a silicon material having a nanocrystalline microstructure, as included in Claim 14 by virtue of its dependence from amended Claim 1. Further, in the Sano et al. reference, the intermediate layer 17 and the interfacial layer 18 are taught together to enhance open circuit voltage. However, neither is taught to independently enhance open circuit voltage. Thus, one of ordinary skill would not be inclined to consider adding only one layer to enhance the open circuit voltage.

Additionally, the Sano et al. reference intermediate layer 17 is taught to be included between the second transparent layer and the p-type layer in order to protect the transparent

conductive oxide layer. Therefore, Claim 14 is not obvious from the combination of the Ma et al. and the Sano et al. references. Thus, Applicants respectfully request withdrawal of the rejection.

VI. Newly added claims recite further patentably distinct embodiments

Applicants have added Claims 79-99 which further describe additional embodiments of the present invention. Support for these claims is found in the specification and drawings. Therefore, the Examiner is respectfully requested to allow these claims.

VII. Conclusion

Based on the foregoing remark, Applicants have shown that neither the Ma reference nor the Kishimoto et al. reference anticipate the invention recited in independent Claims 1 and 77 and dependent Claims 11, 12, 14, and 75, 76, and 78. Additionally, newly added Claims 79-89 also recite the same limitation of the relative thicknesses and transparency between the first and second p-type sub-window layers.

Accordingly, Applicants request withdrawal of the rejections of the claims under 35 U.S.C. §§ 112, 102(b) and 103(a).

In view of the above amendments to the claims and the remarks herein, it is submitted that the specification, drawings and claims are in proper form for allowance. Accordingly, Applicants respectfully request reconsideration and withdrawal of the objections and rejections of record, and allowance of all claims.

VII. Request for Telephone Interview

As a final matter, if the Examiner has any suggestions concerning different claim phraseology that, in the opinion of the Examiner, more accurately defines the present invention, prior to issuance of another Office Action, Applicants' attorney requests the courtesy of a telephone interview at the Examiner's earliest convenience to discuss the application. Applicants' attorney may be contacted at 419-255-5900.